Strategic Astrophysics Technology

Development of Large Area (100x100 mm) photon counting UV detectors

Completed Technology Project (2016 - 2017)

Project Introduction

Microchannel Plate (MCP) detectors have been an essential imaging technology in space based NASA UV missions for decades and have been used in numerous orbital and interplanetary instruments. The reasons for this are many: they have high QE in the extreme and far ultraviolet; they are photon counting with high spatial and temporal resolution; they are available in various large, adaptable formats, even curved; readout electronics can be compact, low mass and low power; they do not require cryogens; and they are quite radiation hard. However, as with any detector technology, they have had their limitations: lower QE in the near UV, MCPs with fixed pattern noise; and limited lifetime and dynamic range as a result of high gain operation. The first of these limitations is being addressed by an APRA grant on GaN photocathodes and the second has been largely ameliorated by new MCP fabrication techniques by Industry. We have addressed the remaining issues with our Cross Strip (XS) anode readout technology. We are currently near the end of our SAT program where we were funded in increase the TRL of XS readout electronics by converting our bulky and high power laboratory designs into application specific integrated circuits (ASICs) that are lower power and lower mass. We also developed a standard 50x50mm XS MCP detector that was tested in flight like environments (thermal-vacuum and vibration). We now have in hand the higher TRL 50mm detector and the ASICs to read it out. The goal of this SAT proposal is to now scale the 50x50 mm detector to 100 x100 mm XS detector using these ASIC and scaling the detector mechanical structure and anode by a factor of two (four in area) in an aggressive 2 year program. The basic ASIC design will not change except we will migrate the 250nm CMOS technology to a more modern 130nm CMOS technology that is known to be faster and more radiation resistant. With this new effort we will have an adaptable prototype 100 mm detector qualified for flight-like environments. Cross Strip readouts collect the charge exiting from a stack of MCPs with two sets of coarsely spaced and electrically isolated orthogonal conducting strips. When the charge collected on each strip is measured, a centroid calculation determines the incident location of the incoming event (photon or particle). This requires many identical amplifiers (e.g. 160, 320) whose individual outputs must all be digitized and analyzed. The advantage this technique has over existing and previous MCP readout techniques (wedge and strip, delayline, intensifiers) is that the anode capacitance per amplifier is lower, resulting in a higher SNR. This allows lower gain operation (factors of ~20) while still achieving better spatial resolution. Furthermore, lower gain operation of the MCPs increases both their lifetime and the local counting rate capability. We plan to take this 50 mm XS technology and scale it up to 100x100mm and raise it to TRL6 from TRL4 by proposing to: (1) Test the sensitivity of the new ASICs to high radiation doses and migrate them to a more robust 130nm CMOS technology; (2) Develop a spaceflight compatible 100x100 mm XS detector that integrates with these electronics and can be tested as a system in flight-like environments while maintaining the imaging performance achieve with the smaller detector (< 20μm FWHM spatial

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

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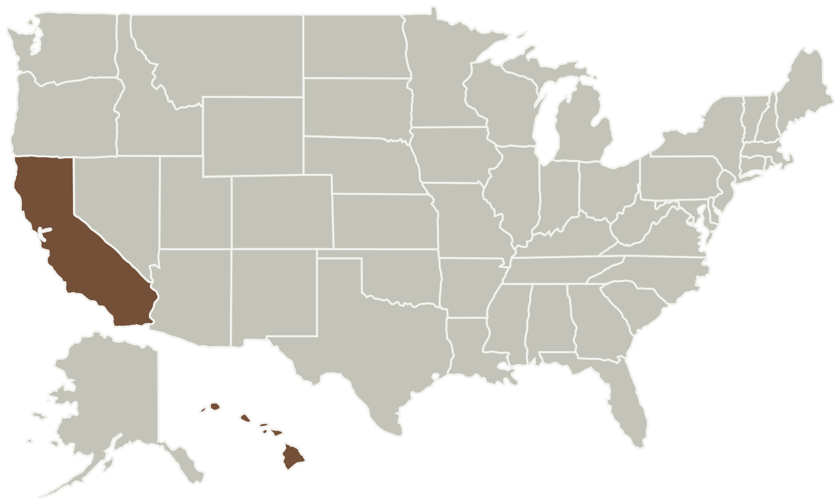
resolution, spatial linearity of < 10μm, count rates > 2MHz , 10% deadtime etc). This detector design can be used directly in many rocket, satellite and interplanetary UV instruments and could be easily adapted to different sizes and shapes to match various mission requirements. Having this detector flight design available will also reduce cost and development risk for future Explorer class missions. New technological developments in photocathodes (e.g. GaN) or MCPs (e.g. low background, surface engineered borosilicate glass MCPs) would be able to be accommodated into this design as their TRL levels increase.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Regents of the University of California	Supporting Organization	Academia	Oakland, California

Primary U.S. Work Locations	
California	Hawaii

Project Management

Program Director:
Mario R Perez

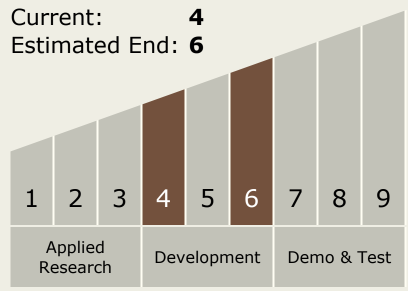
Program Manager:
Mario R Perez

Principal Investigator:
John Vallerga

Co-Investigators:
Gary S Varner
Joyce So
Oswald Siegmund

Technology Maturity (TRL)

Start: **4**
Current: **4**
Estimated End: **6**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.1 Remote Sensing Instruments/Sensors
    └ TX08.1.1 Detectors and Focal Planes

Target Destination

Outside the Solar System